THE NATURE CONSERVANCY NEWS

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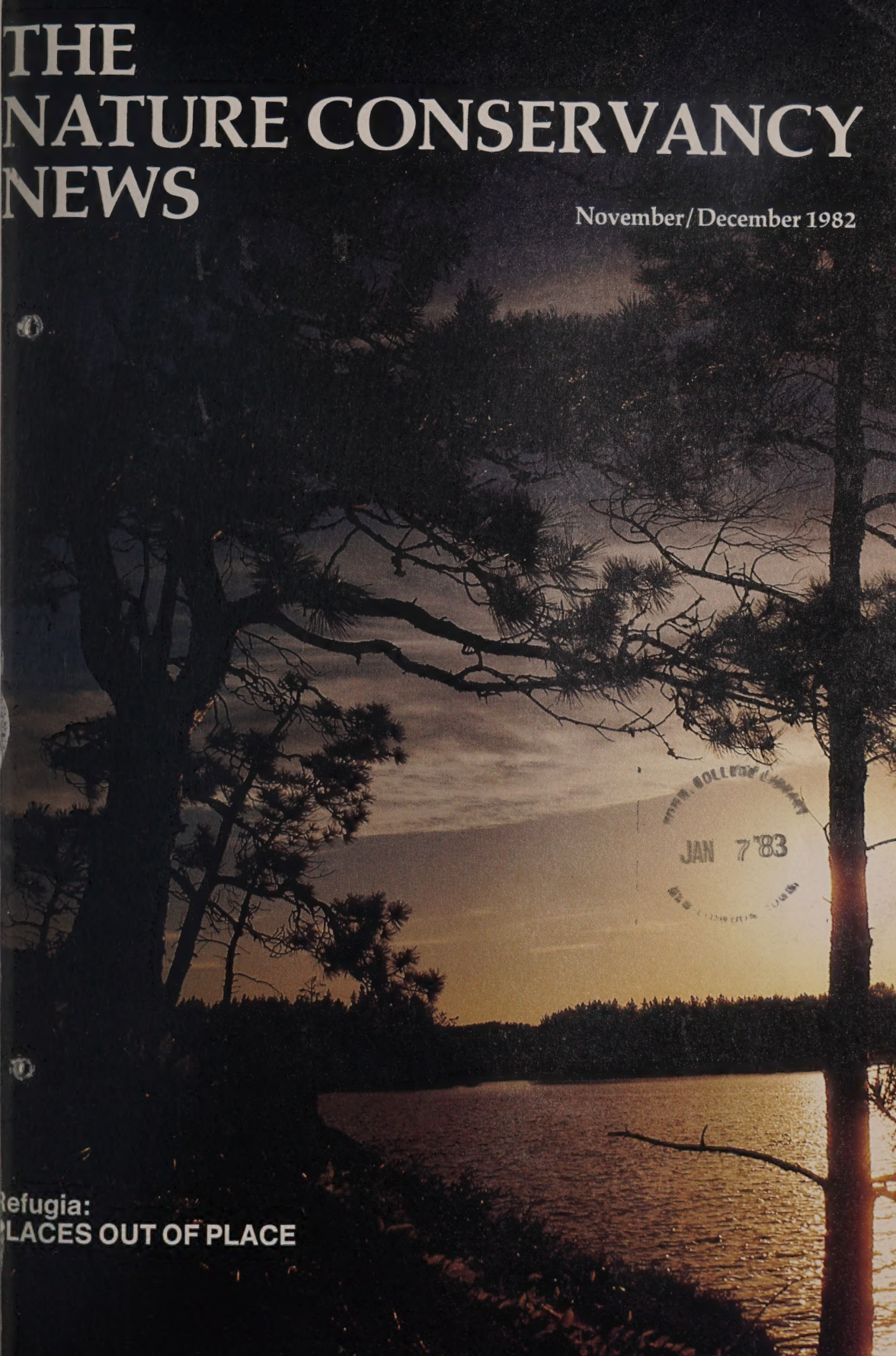

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Refugia:
PLACES OUT OF PLACE

A botanical "refugee"—
a Conservancy preserve.

Larry Morse

Your gift to the General Fund
is a gift of refuge.

THE NATURE CONSERVANCY NEWS

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COVER: The Conservancy's Susie Island Preserve in Lake Superior—a Minnesota refugium, where arctic flora prospers at a temperate latitude. Photo by Susan Bournique.

The Nature Conservancy is a national conservation organization committed to the preservation of natural diversity by protecting lands containing the best examples of all components of our natural world.

To date the Conservancy and its members have been responsible for the preservation of 1,885,944 acres of forests, marshes, prairies, mountains, and islands: home to rare and endangered species of wildlife and plants. 2,972 projects have been completed since the acquisition of the first preserve in 1954. Approximately 60% of all preserves are retained by the Conservancy and managed by staff and volunteer land stewards.

A membership, non-profit organization, the Conservancy was incorporated in 1951 in the District of Columbia for scientific and educational purposes.

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Refugia: Places from the Past

by Larry E. Morse
Staff Botanist

MOST OF US KNOW THAT the mammoths, mastodons, sabre-toothed tigers, giant sloths, and other once-abundant large animals of the Pleistocene Ice Ages are now extinct. No one has ever seen one of these animals alive, and by now no one expects to. But what of the smaller, less conspicuous members of the Ice Age flora and fauna? Might some still be around?

The answer is clearly "yes," and a peculiar area in northeastern Iowa tells the tale. Here, among certain slopes of coarse talus near the Mississippi River, ice accumulates under the loose rocks, persisting through the summer and providing a flow of cool air year-round. These cold-producing (algific) talus slopes have long been known as the only habitat of the Iowa golden-saxifrage. Also there are other rare plants, including the northern monkshood, known only from a dozen or so scattered sites from Iowa eastward to New York.

A zoologist visiting one of these shaded Iowa slopes in 1928 collected some unidentified snails, later determined to be *Discus macclintocki,* a species widespread during the Ice Ages but thought to be extinct. Recent exploration of the sites by Terry Frest of the University of Iowa has shown these algific talus slopes to be the home of two more snail species otherwise known only as fossils, as well as another kind of snail completely new to science. One such site, the Charles and Anna Roggman Boreal Slopes, was donated to The Nature Conservancy in 1981, and our Iowa Field Office is seeking to protect additional sites of this kind.

Cord grass shimmers on a Conservancy-protected AMTRAK prairie strip in southwestern Michigan. Relicts from the xerothermic period (a great heat wave that followed melting of the continental ice), parcels like this persist where prairie plants are secure from invading trees.

Such relict landscapes aren't restricted to Iowa. Consider, for example, southwestern Ohio, today a land of cornfields and suburbs, industry and shopping malls. Long gone are the vast forests of the pioneer settlers and the Indians before them. Yet, even centuries ago, this land was not all oak and hickory, beech and maple. East of Dayton is Clifton Gorge, a ravine along the Little Miami River, purchased in 1963 by The Nature Conservancy, and later transferred to the State of Ohio. Hemlock, Canada yew, white cedar, red elderberry, and red baneberry grow here—plants all common hundreds of miles to the north, but rarely if ever seen elsewhere near Dayton or Cincinnati.

There is also a Great Plains element in the Ohio flora. Small prairies were formerly frequent near Dayton and Columbus. Described by early settlers as treeless, meadow-like openings of grasses and wildflowers and rich, dark soils, they were dominated by big bluestem, a grass often ten feet tall. Even more interesting biogeographically are certain other Ohio prairie remnants on small, exposed dolomite rock outcrops east of Cincinnati. They support little bluestem and side-oats grama, grasses characteristic of the Great Plains, along with dozens of other plants rare in the state. Perhaps the strangest of these species is a five-foot-tall wild agave, far removed from the usual Arizona desert home of its relative, the century plant. Several of

Ohio's relict prairies have been protected in the Edge of Appalachia Preserve System, jointly managed by the Conservancy and the Cincinnati Museum of Natural History.

Like the Pleistocene snail sites in Iowa, these anomalies in the Ohio landscape are all examples of *refugia,* relicts of past landscapes in which conditions remain appropriate for the continued existence of species and communities no longer common in the region. The gorge flora at Clifton dates from late-glacial times in the Pleistocene Ice Ages, when the landscape around the melting glaciers resembled the present landscapes of central Canada. The prairie patches, on the other hand, date from periods of warm climates when the Midwest prairies extended much farther east.

The Refugium Concept

A refugium (plural, refugia) is literally a place for refugees. Biogeographically, a refugium is a place where a formerly more abundant species can survive or persist even though its populations have declined or disappeared in the surrounding area, or in the remainder of its range. Sometimes a refugium is the sole remaining site for a plant or animal; more often, it harbors species otherwise rare in that part of the country, but more common somewhere else. Viewed historically, a refugium is a place that has changed less than its surroundings.

Relicts of the ordinary presettlement vegetation are not strictly refugia to the biogeographer, since the landscape around these sites was altered by human activity in historical times, rather than by natural changes in the climate or topography of the region. Many of the Conservancy's preserves for prairies and eastern forest types are places of this kind, special primarily because they are still there. Undisturbed coastal barrier islands, such as those in the Conservancy's Virginia Coast Reserve, are also becoming increasingly important preserves as development proceeds on shorelines elsewhere.

Like antiques, refugia come in many kinds, and date from many different ages. Some of the most interesting refugia date from the closing millenia of the last great Ice Age, 10,000 to 20,000 years ago. These Ice Age relicts are particularly well represented in The Nature Conservancy's preserve system. Our first preserve, the Mianus River Gorge in New York, is such a place. A few refugia, like the Apalachicola bluffs in the Florida Panhandle, contain relict elements from the landscape that existed millions of years ago, long extinct elsewhere.

The "kipukas" of Hawaii's volcanic areas, on the other hand, are natural refugia of very recent origin, sites left unaltered when lava flows obliterated the presumably similar vegetation around them. Kipuka Pua-Ulu on the slopes of Hawaii's Mauna Loa volcano is perhaps the best known of these places—its mature forest provides a home for numerous rare Hawaiian birds. Sites that by location or chance survived forest fires, landslides, or windstorms are more familiar, mainland examples of such short-term mini-refugia.

Also important as refugia are areas that—because of a lucky location—have not been invaded by livestock, aggressive introduced weeds, rats, wild pigs, or other concomitants of human settlement. Such sites are particularly significant in Hawaii, where the native presettlement flora and fauna had evolved no defenses against land mammals. Tiny offshore sea stacks, for example, often host undisturbed native vegetation that is gone from the adjacent shore. Another such refuge is a precipitously walled plateau on Molokai, accessible only by helicopter. On its summit, only recently explored, is a little-disturbed native 'ohi'a forest, many rare birds, and large stands of two of Hawaii's three native orchid species. Most of the known world population of the Molokai thrush is confined to this summit.

A single out-of-place species rarely means a refugium is involved; more likely, the species arrived recently by long-distance dispersal or through human activity. Birds, storms, and floods, for example, often move plant seeds great distances, and some of these dispersed seeds manage to germinate and survive. (On rarer occasions, these isolated disjunct individuals actually establish new populations, thus expanding the range of their species.) On the other hand, if a site includes several unusual disjunct species, there is a greater chance that it represents a refugium, for it is unlikely the species all arrived at the same place separately by long-distance dispersal.

Conservation of refugia is important because the species there are located in settings different from those of their typical ranges. These disjunct populations are often peculiarly adapted to their surroundings and new competitors. Sometimes they even become distinct species. If the climate or landscape becomes more favorable to their species, refugia can also turn into new centers of dispersal and range expansion. Finally, refugia are significant to scientific research and nature education because they provide conveniently located populations of species characteristic of distant places.

Remnants of the Ice Age Landscape

The North American landscape had not always looked the way the first European settlers found it. About 20,000 years ago, at the height of the most recent Ice Age glaciation, a great ice sheet

Doug Morrison

The Conservancy's Apalachicola Bluffs and Ravines Preserve on the Florida Panhandle; one of the temperate world's richest paleorefugia.

covered the northern half of the continent. Similar to the glaciers now on Greenland and Antarctica, this mile-thick mass of compacted snow spread southward to Long Island, to the Ohio and Missouri Rivers, and to the Great Plains. Mountain glaciers also developed, covering many peaks in the west.

The Earth's overall climate during the Ice Ages was, of course, very different, being generally cooler, wetter, and windier. Only tundra plants could grow near the ice margin. Trees, if any, were confined to protected valleys. Southward from the ice was a series of forest zones: first spruce and tamarack; then pine, spruce, and fir; next oak and hickory; and, in some places, beech and maple. The locations, composition, and abundance of these midglacial forests are still matters of intense debate among paleobotanists and biogeographers, but the general patterns are now clear, mainly due to careful studies of fossil pollen from lakes and bogs (see Ecology Forum, page 22). Forests also extended well out into the present Great Plains in midglacial times, and the cooler climates allowed lakes to form in many southwestern sites that are now dry valleys or alkali flats. Beech, sugar maple, and various other temperate forest species even reached the mountains of Mexico at the height of the Ice Age.

As the climate cooled and the ice advanced, many "Canadian" plants and animals spread south and expanded their ranges in the Appalachians, then spread north again as the climate warmed and the ice melted. Some, like jack pine and black spruce, have no sites left in the Appalachians, and now occur only in the previously glaciated territory. Many other plants and animals, however, left relict populations behind, adding greatly to America's landscape diversity. These glacial-relict refugia are often in such places as cool bogs, shady ravines, or windswept mountaintops, where newly arrived competitors did not become established. The subarctic plateau of the Dolly Sods area of West Virginia, for example, is home to the snowshoe rabbit and numerous "Canadian" plants. This refugium was protected from coal mining by the Conservancy's purchase of 15,559 acres of mineral rights there in 1972. Bluff Mountain, a Conservancy sanctuary in North Carolina, is another example of such a mountaintop refugium. It supports the bog turtle (occurring at one of its southernmost stations), several plant species known nowhere else in North Carolina, and the lichen *Cladonia psoromica,* known nowhere else in the world.

Some species were unable to move northward as fast as the climate changed, and persisted in-

stead in fewer and fewer sites as increasingly competitive new arrivals surrounded them. Presumably, most of these declining species are now extinct, having lost habitat until they vanished entirely. Others, such as Iowa's golden-saxifrage and Pleistocene snail, are barely still with us.

A few remnants of the Ice Age tundra biota still remain in temperate latitudes. Minnesota's Susie Island Archipelago in Lake Superior, for example, hosts purple crowberry, knotted pearlwort, northern eyebright, and several other arctic plants rare in the Great Lakes region, growing together in crevices of exposed rocks just above the icy waters of the lake. Norwegian whitlow grass, found on Susie Island, occurs next on Hudson Bay, and ranges from there east through Greenland and Scandinavia to northern Siberia. Susie Island itself was acquired by The Nature Conservancy in 1980, and protection of the neighboring islands is currently being pursued by the Conservancy's Minnesota Chapter.

Most of the midglacial lakes of the southwestern U.S. are now dry alkali flats; but remnants of a few of the largest of these lakes persist, including Mono Lake in California and Great Salt Lake in Utah. Several smaller remnants of midglacial wetlands also persist as refugia. Best known of these is Ash Meadows, a Mojave Desert oasis not far from Death Valley. Formerly a series of shallow lakes, this small area has one of the greatest concentrations of endemic species in the continental United States. Three kinds of fish, several snails, six plants, and two insects found at Ash Meadows occur nowhere else on Earth. One critical site, a 30-foot deep pool, was purchased by The Nature Conservancy in 1973 and later transferred to the Bureau of Land Management as habitat for the endemic Ash Meadows Amargosa pupfish. Yet, key tracts of the land at Ash Meadows are owned by a subdivision developer who plans to sell 20,000 lots in this desert valley.

The Niobrara Valley Preserve, at 54,000 acres the Conservancy's largest sanctuary, is a dramatic example of a "forest-in-prairie" refugium—an area in which the advancing prairie surrounded relict pockets of forest landscape. Purchased in 1980 for more than $10 million, Niobrara is rightly called the "biological crossroads of the nation": six major natural communities blend here.

Twenty thousand years ago, Niobrara was near the edge of the glacial ice. Today, the hot, dry Nebraska sandhills prairie borders the Niobrara River bluffs. Ponderosa pine grows on the slopes, left there from an earlier coastal extension of the Rocky Mountain forest into the present prairies. Even more peculiar is a stand of white birch along the cool, shaded valley side, possibly dating from late-glacial times. The small woodrat, disjunct from the eastern forests, lives on the slope with the birches. Midglacial fossils of this same woodrat species have been found at Niobrara, together with fossils of several large extinct Pleistocene mammals: the American mastodon, the wooly mammoth, a large bison, and a peculiar llama-like native camel.

The Xerothermic—The Great Heat Wave

The general idea of the Ice Age landscape is familiar to almost everyone, although the cartoonists differ with the paleontologists in enriching the diversity with dinosaurs and other long-extinct animals. Not as well known is the "xerothermic period" of several thousand years ago, a warmer (and in places drier) time at the peak of the millenia-long heat wave that melted the ice. During the xerothermic, prairies and some deserts expanded, at the expense of forests, lakes, and tundra. For example, the midwestern prairies extended eastward well into Indiana and Ohio as a "Prairie Peninsula" between the Great Lakes forests and the densely wooded southern Appalachians.

Then, as the climate cooled a few thousand years ago and the forests returned, patches of prairie remained in places that trees did not com-

Attempts to explain prairie plots lodged in the Ohio woods gave rise to the xerothermic theory in the 1920's. One such refugium tops Conservancy-protected Buzzardroost Rock, above.

Alice Q. Howard

The Antioch Dunes evening primrose, endemic to California's Central Valley, is derived from a desert biota eclipsed here long ago.

pletely invade. Some are a fraction of an acre in size, yet so diverse botanically that they represent true prairie communities. The 36-by-81-foot Buzzardroost Rock in Ohio, for example, has 13 unusual prairie plants on its summit. It was protected by the Conservancy on six weeks' notice in 1958. Other prairie relicts were much larger, covering hundreds or thousands of acres, but these treeless grasslands were generally plowed and farmed by European settlers. Often the only remnants of these sites are in pioneer cemeteries and along railroads, including such Conservancy preserves as the AMTRAK Prairies in Michigan or the cactus-strewn sand prairie at Spring Green in southwestern Wisconsin (see page 17).

The southern flora also moved farther north during the xerothermic, leaving patches behind in favorable places as the climate later cooled. In New Jersey, near Atlantic City, are several round depressions in the sandy pine barrens forest. They fill with a foot or two of water in the spring but are dry and ablaze with wildflowers by fall. These hollows offer a northern refugium for diverse southern plants that have otherwise retreated to the Carolinas, Georgia, and Florida. Rarest of the sites' showy late-summer flowers are the awned meadow-beauty, the snowy orchid, and the delicate Boykin's and Canby's lobelias.

In the Southwest, the retreat of the extensive xerothermic desert scrub and semi-desert grassland also left many relicts behind, some of which are significant refugia. For example, the Antioch Dunes in California's Central Valley farmlands support several endemic plant and insect species derived from the desert biota, including the Lange's metalmark butterfly, the Antioch Dunes evening primrose, and the Contra Costa wallflower.

Sea-Level (and Lake-Level) Changes

Changing shorelines have also produced many refugia. During the height of the Ice Age, an immense quantity of snow was frozen into the glaciers, interrupting the usual pattern of snowmelt and runoff. Since evaporation from the oceans

continued—exceeding river flow into the seas—the sea level fell some hundreds of feet, leaving dry land instead of ocean bottom scores of miles outward from the present shoreline.

Then, as the ice melted and the sea level rose, the ocean flooded this former midglacial mainland shore, leaving various upland areas as offshore islands or peninsulas. Long Island, Cape Cod, Martha's Vineyard, and Nantucket—all remnants of the old mainland—are now refugia for such late-glacial coastal plants as corema, sand heather, and bearberry, as well as *Agalinis acuta,* thought to be extinct until rediscovered on Cape Cod by the Massachusetts Natural Heritage Program in 1980. Martha's Vineyard also served as the final refuge of the now-extinct heath hen, last seen there March 11, 1932.

In areas near the ice margin, however, the weight of the glacial ice sank the land itself several hundred feet. Since this was lower than sea level had fallen, the oceans in these sites spread inland, leaving hilltops or mountains as islands. Later, as the ice melted, the land recovered from the extra weight, rising and returning the shorelines to their present pattern. Relict coastlines from the Ice Age can be found well inland in New England and Canada. For example, near Lac St. Jean north of Quebec City, immense, shifting dunes covered with dune grass, sand heather, and other coastal plants still stand in the Canadian forest. Many inland lakes also had higher shores at that time, before their outlets eroded down to modern levels. Around Lake Michigan, for instance, relict dunes are common, perched atop bluffs well above the present lake level. The Conservancy's Kitchel Dunes Preserve in Michigan includes examples of these ancient dunes and abandoned late-glacial lakeshores.

Much of the sandy interior of peninsular Florida was former ocean shore. Geologists have found pine-covered dunes, beaches, and sandbars there, 60 feet or more above sea level. These sandy uplands are now covered with "sand pine scrub," a mosaic of forests and openings, including low pine trees, thick-leaved scrubby oaks, saw palmettos, and Florida rosemary. More plant and animal species endemic to Florida are found in this pine scrub region than in any other habitat in the state. One, the Florida scrub lizard—a species related to similar lizards of open habitats in the South-

The ghost of an ancient ocean shore endures in peninsular Florida's sandy interior, where sand pine scrub communities (at left) harbor more endemic species than any other habitat in the state—the Florida scrub lizard (above) among them.

The Florida torreya, an evergreen alive today at Apalachicola Bluffs, closely resembles torreya fossils from the age of dinosaurs.

west—probably entered the state about two million years ago, when drier conditions were more widespread in the Southeast. It has persisted since then in this habitat, along with the Florida scrub jay, an endemic subspecies related to the various western scrub jays. Tiger Creek, a 2,800-acre preserve established by the Conservancy, harbors both the scrub jay and the lizard, along with such endemic plants as the pygmy fringetree and the sweet-scented butterfly-pea. Acquisition of additional sand pine scrub is a top priority of the Conservancy's Florida Field Office.

Paleorefugia—Ancient Relicts

Paleontologists—scientists who study ancient life—usually need to deal with fossils, because most plants and animals characteristic of landscapes millions of years ago are now extinct. But a few such ancient species still survive, often at sites known as "paleorefugia." For example, fossil forests of petrified wood dated as millions of years old are familiar sights in the American West. Most people would think the tree species that formed these fossil forests were long extinct. Imagine botanists' surprise when a Chinese schoolboy discovered a living tree of *Metasequoia glyptostroboides*, the very species that formed many of our petrified forests. Scientific expeditions rushed to the site, a remote mountain valley in southern China, and were delighted to find not only dense groves of the redwood-like metasequoia trees, but numerous relict associates, all members of ancient genera. Clearly this place was a refugium of great antiquity, a paleorefugium persisting relatively unchanged for millions of years while the landscape everywhere else had changed dramatically. The metasequoia was brought into cultivation and found to be fast-growing, attractive, and unusually tolerant of air pollution. These feathery-foliaged "living fossils" are now becoming familiar sights in American cities.

One of the temperate world's richest paleorefugia is the Apalachicola River bluffs area in the Florida Panhandle. Here, for 25 miles along the Apalachicola River, the longleaf pine sandhills end abruptly in dense ravine forests of beech, magnolia, and holly. These moist, sheltered hillsides support 52 of the 342 species on the Florida Natural Areas Inventory plant list. Among them are the Florida yew and the croomia, relicts of the flora of millions of years ago. Florida torreya, an evergreen tree found only in the Apalachicola ravines, closely resembles fossil torreyas from southern Appalachia, which were dated as about 100 million years old—well back into the age of the dinosaurs. Many woodland plants characteristic of the Appalachians, such as the wild hydrangea, also have their only Florida occurrences on the Apalachicola bluffs. Although this area has attracted curious botanists since the 1830's, Conservancy-sponsored field research this past summer in the ravines turned up seven plant species previously unknown in the state. Last June, The Nature Conservancy bought a choice 1,158-acre tract of bluffs and ravines on the Apalachicola River. The property protects the torreya, the Florida yew, and the croomia (the three best-known Apalachicola plants), as well as other rare plants and several disjunct or endemic salamanders.

It must be stressed that refugia don't occur everywhere; yet there are a great number of such sites in a landscape as diverse as North America. Amateur and professional naturalists are discovering new kinds of refugia each year, as the peculiarities of the landscape are more intensely explored; and biogeographers are still trying to understand the complexly intertwined changes in climate, topography, and geography that caused these curious places to be left behind. Many of the lands being protected by The Nature Conservancy are categorized as refugia of one kind or another. An even greater proportion of refugia can be expected among future Conservancy projects and acquisitions, as State Natural Heritage Programs and other inventory efforts continue to locate these unusual pockets of unexpected species —these places out of place.

Visit to an Ice Age Relict

Shellie Gareau

by Anne M. Byers
Associate Editor/Staff Writer

MY FIRST GLIMPSE of the bog called Cranesville Swamp was from a sinuous country road in westernmost Maryland. Not a noteworthy sight from a distance, but then, as I soon learned, a bog is only seen and felt as you slog through it. The narrow dirt and rock lane that circumvents Cranesville was in itself an experience. I wished that my tiny, aging Honda would turn into a four-wheel-drive vehicle.

En route we crossed from Maryland into West Virginia. Leaving the car half on and half off the road, we started to hike down the meandering half-mile trail that leads to the bog. I was accompanied by George Fenwick, a Conservancy ecologist who would identify plants, and Shellie Gareau, another staff member eager to see one of The Nature Conservancy's preserves. As we dodged low-hanging limbs and the thorns of hawthorn trees, George—who is a birder as well—interrupted our trek every few feet to chatter at a songbird. It was too late in the year (the first of October) to see the most interesting breeding species, but George wasn't the least deterred. A few chickadees, magnolia and black-throated green warblers, golden-crowned kinglets, and juncos still could be found in the surrounding forest. George's chirps and chatters seemed effective—a black-capped chickadee alighted on a branch just above our heads and sang back its name, "chickadee-dee-dee."

The path stopped abruptly at the very edge of the swamp. As my sneakered feet sank into the sphagnum moss, and water rose well over my ankles, I felt enveloped by the landscape. The atmosphere was primeval, enhanced by the bog's isolation and totally different appearance from the familiar woods and hills of western Maryland and northern West Virginia. But then, Cranesville Swamp *is* primeval: the fossil record (see Ecology Forum, page 22) for the area shows that the bog is at least 10,000 years old and supports plant species that were common in the region during the

Author Anne Byers and ecologist George Fenwick "botanize" amid swaying cottongrass at Cranesville Swamp.

Pleistocene Ice Ages. How did this place, so unlike the land around it, come into existence?

During the Pleistocene Epoch, when Canada and the northern United States were covered by ice, the advancing glacial sheets "pushed" to the south plants and animals native to northern regions. These species eventually dominated what is now Maryland and West Virginia. When the glaciers retreated and the climate warmed, the northern flora and fauna gradually disappeared and were replaced by southern species, except in a few unusual places like Cranesville. Here, a small piece of what was once a vast boreal forest remains as a relict colony. But why does it persist? First, the bog lies on the Allegheny Plateau at an elevation of about 2,500 feet, where weather is cooler year-round than in the lowlands. Also, temperatures are lower in the swamp itself because it lies in a bowl-shaped area where colder air flowing down the sides replaces warm air in the center. This produces a natural "frost pocket"—an effect that is particularly noticeable in early fall, when the bog's shrubs and trees have turned red and yellow before those on the surrounding higher ground. Cranesville's high altitude and soup-bowl topography, combined with poor drainage (the swamp is underlain by an impervious bed of silt and hard limestone), create a cold, moist condition characteristic of Canadian bogs. Thus, much of the plant and animal life that thrived in the region during the Ice Age has lingered in this boreal bog.

For example, goldthread, a little evergreen plant that produces a single white flower, is abundant in the swamp's red-spruce forest. It grows as far north as Greenland. The tiny round-leaf sundew flourishes here as well, the only naturally occurring insectivorous plant in the bog. Other species with northern affinities include bog fern, swamp saxifrage, Jacob's ladder, Canada yew, kidney-leafed twayblade (an orchid), and creeping snowberry. According to Brian McDonald, staff ecolo-

John Trott

Familiar in Canadian bogs and forest edges, the Nashville warbler (right) finds the southernmost extension of its breeding range here at Cranesville on the Maryland-West Virginia border (below).

George Fenwick/Joel Horne

gist with the West Virginia Wildlife and Natural Heritage Data Base, Cranesville Swamp is a "pocket for all these plants, which our program lists as rare in the state."

Many animal species inhabit the site as well, particularly amphibians, snakes, and small mammals like shrews and mice. The mountain earth snake, a subspecies of the smooth earth snake, is found at Cranesville along with the eastern ribbon snake. Both are considered rare in West Virginia. The Nashville warbler, which dwells in Canadian bogs and forest edges, nests in the swamp—the southernmost point of its breeding range.

But Cranesville's most interesting resident is the northern water shrew, first sighted there in 1941. Maurice G. Brooks, retired professor of wildlife management at West Virginia University, described the elusive creature to me as "a northern species having a disjunct population in the Appalachians. It is very scarce." As a matter of fact, the animal has been reported only seven other times from the state. Brooks (a leading authority on the flora and fauna of the Appalachians), also said that "at two-and-a-quarter inches, the northern water shrew is North America's smallest mammal." Yet the diminutive animal, like other shrews, must eat constantly to satisfy its enormous energy needs. "If unfed it will die in six hours," Professor Brooks added.

OUR VISIT TO CRANESVILLE took place on an unusually warm though overcast fall day; we entered the swamp just after noon. Fringed with sedges and cattails, small ponds to our right still lured dancing dragonflies. But the summer sound of startled frogs plopping into the water was gone. An intermittent breeze hindered the few mosquitoes and made the tufts of cotton grass bounce and sway. Typically native to Canada and Alaska, cotton grass (really a sedge) is aptly named—its thin, two-to-three-foot-tall stems are topped by fluffy white seed heads that mimic cotton bolls.

We immediately began watching the saturated ground, both to identify the low-lying vegetation and to avoid sinking too deeply into the black peat. The bog was covered by a multi-colored carpet composed of as many as 20 different sphagnum moss species. The diverse shades—ranging from light to dark green and including reds, yellows, and browns—were determined by the moss species and the varying water levels (not, as I had thought, by the season). Growing perhaps only inches higher, cranberry and blueberry shrubs intermingled with the mosses. The blueberry plants grew upright; the cranberries, however, stretched their vine-like branches across the spongy sphagnum mats. We were too late for blueberries, but we munched the tart red cranberries as we wandered about, our footsteps causing the moss beds to squish and gurgle.

Though the sphagnum carpet in this corner of the bog was uniformly sprinkled with cotton grass and cattails, Cranesville is a wetland complex rather than a single community type. Looking out across the swamp, we could see a large stand of sedges beyond the cattails and cotton grass; to its right stretched a tangle of tall grasses and black and red chokeberry. The chokeberries' leaves were a vivid wine red. Behind these two areas, the bog became a shrub swamp, encompassing alder, mountain ash, viburnum, and mountain holly. Finally, beyond the shrub-swamp, the bog's red-spruce forest emerged—primarily a mixture of red maple, black cherry, white pine, hemlock, and red spruce, interspersed with rhododendrons and ferns.

A large part of this wetland complex was established as a sanctuary in 1960 when The Nature Conservancy purchased approximately 260 acres. Now containing about 300 acres, the bulk of the Cranesville Swamp Nature Preserve lies in West Virginia. However, it is managed jointly by the Conservancy's Maryland and West Virginia Chapters. Sloshing through the swamp offers the best "bog experience," but too many visitors will eventually damage the sphagnum mat; thus, the preserve's stewardship committee, directed by Drew Ferrier, plans to build a boardwalk reaching into the swamp.

FROM CRANESVILLE'S NORTHWEST corner, we started hiking southeast, crossing the swamp diagonally. We passed a copse of broad-leaved cattail, then entered the area dominated by sedges. "Sedges have edges," George announced. Shellie and I looked blankly at each other. Finding a species of rush growing nearby, George demonstrated his saying. Rushes and grasses are usually round-stemmed and therefore smooth; many sedge stems, on the other hand, are triangular and so have edges. The difference is apparent when the two plants are handled.

There among the waist-high sedges I stepped on something round and hard, hidden among the lower mosses and cranberry and blueberry plants. Bending down for a closer look, I prodded the dark-brown object with a short stick. It resembled a small hand grenade. Though it was late in the year for the seed heads of a skunk cabbage (the plant reputedly smells like its namesake), that's what it was—one that had not broken open to disperse the seeds lying just beneath its leathery surface.

A difference of inches in elevation in Cranesville Swamp seems equivalent to a difference of feet in other landscapes. Consequently, a patch of ground only an inch or two higher (and drier) than the surrounding wet sphagnum frequently supports a different community of plants. For example, most of the small, foot-high hummocks scattered throughout the bog's more open areas were capped by a tall, red-stemmed moss called *Polytrichum juniperinum* (easily identified by the shape of a star at the tip of each individual, dark green shoot). This moss was so thick and lush that it felt like a densely furred animal.

Protruding from the surface of the sphagnum, occasional rotting trunks of long-dead trees supported their own small gardens. British soldiers, a lichen resembling groups of tiny red-tipped match sticks, intermingled with club mosses and fluffs of grayish-white reindeer moss, also a lichen.

Shellie Gareau

Fenwick by Cranesville's most significant feature: eastern larches (also known as tamaracks) in their southernmost stand.

WE EVENTUALLY TURNED around, making our way toward the wooded portion of the bog in the northeast. Though the ground grew higher—and the cranberries, rhododendrons, and ferns increased—we could still sink knee-high into the peat, especially in spots where deer had passed through the swamp. Spruce, hemlock, and maple dominated the forest. The yellow leaves of an aspen trembled in the wind, and waxwings called in the distance.

Within the forest we pushed our way through the dense understory, intent on finding an eastern larch—Cranesville's outstanding relict species. We eventually counted seven larches, the tallest standing at about 20 feet, the others ranging between 4 and 9 feet in height. Although the larch or tamarack is a conifer, it is not evergreen. Before dropping in the fall, the needles turn golden yellow, a sharp contrast against the tree's scaly, deep-brown bark. Cranesville Swamp is the southernmost point of growth known for this species, which is more commonly found throughout the Canadian provinces to Alaska and is generally limited to sphagnum bogs and swamps.

Before leaving the forest, we discovered what could be called a tiny island in the wet bog. We were compelled to stop. Surrounded by pines, maples, and autumn-gold ferns, the ground was blanketed by a thick, vivid green mixture of sphagnum and *Bazzania* (a liverwort). Fallen red maple leaves embellished the verdant carpet like lights on a Christmas tree.

The forest now behind us, we began hiking back across the bog, going south, then southwest. The wind had stopped and the cloud-laden sky predicted a heavy rain. Thunder mixed with the higher sound of spring peepers. On the west side we found two healthy clumps of insectivorous pitcher plants, an introduced species very much at home in the swamp's acidic environment.

As we climbed the wooded slope that forms the western wall of Cranesville's "bowl," large intermittent rain drops pattered on the surrounding leaves. Our timing was excellent—just as we closed the car doors, the deluge began. We drove away slowly, the rainwater now puddling and swirling in the rutted gravel road. From the paved road overlooking the bog, the entire area was obscured by curtains of water. George bemoaned not remaining in the swamp during the storm, to experience this rare relict of the Ice Age in one more of its many moods.

Blossoming prickly pear cacti.

Of Prairies and Prickly Pears

by Jeffrey P. Cohn
photos by Virginia Kline

THE WISCONSIN RIVER cuts a broad path, four miles wide in spots, near the southwest Wisconsin town of Spring Green. Steep limestone and sandstone bluffs rise as high as 300 feet above the valley floor. Sand terraces, formed primarily from glacial debris that the river deposited here as the last Ice Age ended 10,000 years ago, bear remnants of the great western prairie that once spread into the distance. In spring and summer, the prairie grasses, cacti, and flowering forbs blossom, creating a brilliant collage of reds, purples, oranges, and yellows.

But this image of the Wisconsin River Valley can be deceptive, for it masks the desert-like nature of the area's sand prairies. Indeed, the area around Spring Green is called the "Wisconsin Desert." Although the region averages about 30 inches of rain a year, the sandy soils retain little moisture. What water does remain is largely evaporated by winds that sweep up the valley. In some spots, low humidity, sandy soil, and south-facing hillsides combine to produce fluctuating ground temperatures reminiscent of deserts: climbing as high as 110 degrees Fahrenheit on summer days, they can plunge 60 degrees or more at night.

Once spread over 13,000 acres, most of these dry sand prairies have been replaced in the past century by farms, houses, highways, and railroads; today, little more than isolated patches remain. But concerned conservationists are protecting a part of the former prairie and restoring it to its former richness.

The Wisconsin Chapter of The Nature Conservancy has joined with the Madison-based Head Foundation, the State Scientific Areas Preservation Council, two private landowners, and scientists

from the University of Wisconsin to create Spring Green Prickly Pear Prairie Natural Area. Located 30 miles west of Madison, the preserve consists of a 260-acre parcel bought by The Nature Conservancy in 1972 and two other tracts totaling 220 acres, which are privately owned but included in the sanctuary under management agreements. The Conservancy has managed the entire preserve since 1974.

Considered the best remaining sand prairie in southwestern Wisconsin, Spring Green's 480 acres are a haven for a biological community usually found in hot, dry environments farther south and west. But, while most refugia are identified by their unusual flora, Spring Green is characterized by its fauna. Numerous mammals, reptiles, and invertebrates found nowhere else in the state inhabit the sand prairies of the Wisconsin and Mississippi River Valleys. For most of these species, Wisconsin is the northernmost extension of their ranges.

The Nature Conservancy's goal is to protect Spring Green's plant and animal life, restore and maintain the dry sand prairie, and preserve the area's singular character. The sanctuary encompasses remnants of abandoned farm fields and buildings (including an old turkey farm), dry sand prairie, a lime prairie, steep hillsides and bluffs, and heavily wooded forests. Each is cared for differently: management ranges from active burning and cutting to little or no interference at all.

THROUGHOUT THE PRESERVE, sand dunes reveal the area's desert-like character, the sandy soil giving way beneath each footstep. Here and there in the dunes, winds have carved out large sand blow-outs that look like immense old wash basins. These elliptical hollows are up to 200 feet long, 12 feet deep, and 60 feet wide, their edges eerily described by uprooted plants. The erosion is halted only when the winds uncover a pavement of pebbles or silt—yet another leftover from the river's former course—and plants can take hold among the shifting sands.

Although they were certainly present before farms replaced prairies, the dunes and blow-outs may have been enlarged by human activities. Farmers plowed up the prairie sod, exposing the dry, sandy soil to the winds. Then, when drought struck in the 1930's, much of the soil around Spring Green was blown away. Many farms were

A "blow-out" or breach in the sands of Spring Green Prickly Pear Prairie Natural Area.

Jointweed, a prairie annual whose almost leafless stems are distinctly jointed, is well adapted to semi-arid Spring Green.

abandoned; some farmers switched from corn, which usually requires richer soils, to more hardy squashes. Lines of pine trees were planted to shield the fields from the winds.

The sand dunes are far from sterile. A small gray shrub, the sand heather, creeps along the ground, its hard leathery early-spring leaves barely hinting at the bright yellow flowers that will blossom in June. Jointweed, a prairie annual, features distinct joints and nodes on its six-inch tall stem. Toadflax sports oval-shaped leaves that shed sand like an upside-down spoon. Like many prairie annuals, this snapdragon's tiny purple flowers bloom and die by midsummer.

The penchant of prairie annuals to flower, seed, and die before the summer sun is at its hottest is only one way Spring Green's plants have adapted to their dry environment. For example, the lead plant, so named because it sometimes grows on hillsides rich in lead, turns its leaves sideways to avoid the sun's direct rays. Little bluestem grass sends its roots as far as five feet down in search of water. In contrast, prickly pear cacti (*Opuntia compressa*) store water in their fleshy pads and stems. Since they prefer semi-arid lands like the sand prairies to true deserts, these cacti are right at home at Spring Green. Thousands of prickly pears flourish on nearly 200 of the preserve's 480 acres. Beginning in June, they produce large pale yellow blooms and—later in summer and fall—sweet, edible purple fruits.

Junegrass and little bluestem intermingle with the cacti on the area's sand terraces. These grass species once dominated Wisconsin's sand prairies. More recently, however, trees have made their way onto the former grasslands, bringing with them forest herbs and shrubs like sumac. The proliferation of trees was aided, again, by human activity. Winds that swept across Spring Green from time to time spread lightning-ignited fires, burning off tree seedlings and clearing the land for grasses and forbs to grow. Now, plowed and irrigated fields break the fires that once kept the trees limited to a few clumps near rivers and prairie potholes or on steep slopes. Agriculture also brought cattle, which, of course, eat grasses but often leave seedlings like black locust untouched. If left unchecked, black locust can invade prairies at up to 30 feet a year.

FROM THE OLD FIELDS that lie to either side of the preserve's entrance, the land becomes sand prairie, rising gently to the north, then climbing abruptly to scale the high bluffs. Because the bedrock beneath the precipitous slopes is composed largely of limestone, the grassland covering the incline is loosely described as lime prairie. In spots, junipers, black locusts, and sumacs grow thickly. Rubble ranging from pebbles to large boulders—fallen from the eroding cliffs above—is strewn about the hillsides. Timber rattlesnakes hide in the rocky crevices, emerging at night to hunt rodents and other small creatures.

The view from atop the bluffs takes in Spring Green's sandy grasslands and fields as they reach to meet lush pastures and croplands, irrigated by huge rotating sprinklers. The Wisconsin River flows beyond. Even the town of Spring Garden is within sight, its newer homes touching what was once farmland. But looking at the preserve's sandy prairies and wooded hillsides from above is a bit like observing the tip of an iceberg: they hide a largely unseen world that, like the prickly pear cactus, contributes to Spring Green's unusual character. The only surface traces of this hidden world are scattered humps of dry sand, testimony to the work of pocket gophers. These mounds, evidence of extensive underground tunnels and burrows, reflect one of the vital relationships between animals and plants at Spring Green.

Ordinarily, prairie grasses form a dense sod that prevents many annual plants from sprouting,

At home on the "Wisconsin Desert": the six-lined racerunner (left) and the ornate box turtle (above).

thus reducing the diversity of the flora and the animals that feed on it. But the pocket gophers limit the spread of grasses and other plants by eating their roots. The gophers are aided in this task by swarms of grasshoppers—which leap about as you walk through the summer grass—and by meadow voles. Furthermore, by digging and excavating, both gophers and ants create patches of open ground where plants can take root. Western three-awn grass, furrowed flax, and croton all sprout along the edges of sand dunes and gopher and ant mounds. In all, nearly 40 species of annuals and biennials grow at Spring Green. While not an unusually large number for a desert, it is for a prairie, where perennial plant species typically dominate.

Orie Loucks, science director at the Institute of Ecology in Indianapolis, Indiana, and Spring Green's first land steward, elaborates on the interdependence of plants and animals on the preserve: "Most biological communities are controlled by the availability of basic nutrients and water, but here many of the plants depend on habitats created by animals. The plants and animals interact to a greater degree than in most terrestrial ecosystems."

For example, many of Spring Green's animals depend on the prickly pear cactus. Snakes and lizards hide under its pads to avoid the sun; gophers eat the roots and stems; ground squirrels and mice gather its seeds; voles and ornate box turtles (*Terrapene ornata,* considered endangered in Wisconsin) dine on its fleshy pads. Birds sometimes nest among the cacti, whose sharp barbs protect eggs and nestlings by warding off would-be predators.

Gopher tunnels also provide homes for several of Spring Green's 10 snake species. The bull snake (*Pituophis melanoleucus*) invades gopher burrows in search of prey. Once satiated, the reptile often takes over its victim's den to escape the hot sun.

ON THE EAST SIDE of the preserve lies Spring Green's former turkey farm. Remnants of the birds' screened enclosures and other debris from the farm still litter the ground but have been left untouched because they shelter many of Spring Green's snakes, lizards, voles, and other animals. In fact, the abandoned farm has become habitat for such creatures as six-lined racerunners and uncommon blue racers.

But the invertebrates are perhaps the most unusual of Spring Green's fauna. Some of the preserve's numerous spiders and insects are found nowhere else in Wisconsin. Most live in dry, sandy habitats along the Mississippi River and its tributaries and may have reached the Conservancy's

sanctuary by migrating along Wisconsin River sand terraces. Both black widow and wolf spiders are Spring Green residents, haunting the sand dunes mostly at night. "The place is a regular circus after dark," says Susan Reichert, a University of Tennessee zoologist who studied the preserve's arachnids. "It's like an island in the middle of an ocean for them."

Unlike the black widow, which tunnels among rocks on hillsides or in debris-strewn fields, wolf spiders prefer the sand dunes. Three species of these large arachnids occur at Spring Green. The burrowing wolf spider (*Geolycosa wrightii*) waits for prey to pass by the door of its burrow, then attacks. The other two build "lookout" turrets atop their dens and from there watch for prey. Of these two wolf spiders, one lines its tunnel with spider silk and grass, the other uses silk and sand. The latter, *Lycosa carolinensis,* is North America's largest wolf spider.

Among the unusual insects, five cicadas live here. One, *Diceroprocta vitripennis,* is found in Wisconsin only at Spring Green. Its covered timbals (the organs that produce cicadas' characteristic buzzing noise), narrow wings, and steady buzzing sound separate it from the four other cicadas. Similarly, of Wisconsin's eight tiger beetles, one (*Megacephala virginica*) is a subtropical species found only on the state's dry sand prairies, including Spring Green. Yet a third unusual insect is a predatory wasp that lays its eggs on the bodies of spiders it has paralyzed.

The relict sand prairie of Spring Green.

Larger predators also prowl Spring Green, though most remain hidden, hunting primarily at night or in the early morning. These include shrews, badgers, gray foxes, raccoons, and skunks. Few make the Conservancy's preserve their sole hunting grounds but come and go as whim and food supply dictate.

WITHOUT The Nature Conservancy's Spring Green Prickly Pear Prairie Natural Area, many sand prairie animals could not live in Wisconsin. But protecting and restoring their habitat will take considerable effort and imagination. "We don't know yet exactly how best to manage the site," says Orie Loucks, "but we're learning. We do know that you can't just leave it alone."

Early successional plant species like Russian thistle and daisy fleabane typically thrive in disturbed soils, like those found in Spring Green's old fields. As the ground lies fallow, however, these plants will probably be replaced by prairie grasses and annuals, although this could take some time. "It may be a century before the entire preserve looks like a viable prairie again," says Virginia Kline, a University of Wisconsin botanist and Spring Green's current manager.

In order to restore the prairie, the Conservancy's Wisconsin Chapter has resorted to nature's method: fire. Last April, a carefully planned and controlled fire burned 60 acres of sand and lime prairie and charred the encroaching juniper trees. While smaller junipers are killed by fire, larger ones can survive. Thus, the Conservancy has also begun cutting down some of the trees, a formidable task since the junipers are so plentiful. Early spring fires will continue to be the primary method of reclaiming Spring Green's grasslands. "We're not sure yet whether the prairie will return where the trees were densest," Dr. Kline says, "but we think it will because it already has in less thickly wooded areas."

With its sand dunes and blow-outs, prickly pear cacti, high bluffs, and acres of sand prairie, Spring Green certainly differs from the surrounding fields and farmlands. But that is fine with Virginia Kline, her colleagues, and the sanctuary's many volunteers. "Our goal is to restore the prairie," says Kline, "and we'll do whatever is necessary to preserve it."

A free lancer, **Jeffrey P. Cohn** typically writes about science, technology, zoos, and wildlife conservation. His articles have appeared in *Smithsonian* and *Defenders.*

ECOLOGY FORUM

No. 47

by Estella B. Leopold
Director, Quaternary Research Center
University of Washington

PALYNOLOGY: A KEY TO LOST LANDSCAPES

Each summer a spray of pollen and plant spores settles over the land—a phenomenon known all too well to hayfever sufferers. The pollen count has become as familiar a daily statistic as the relative humidity. Less familiar is the fact that scientists can read the microfossils of pollen and plant spores to trace vegetational history over thousands of years.

The study of these deposits is called palynology, a 50-year-old science that holds the key to lost landscapes. Once the circulating dust of pollen and spores has settled into bogs, marshes, and lakes, it is "recorded" in the peat or mud that's building there (inch by inch, year by year). Because most pollen grains are resistant to decomposition, owing to the durability of their membranous outer coats, they are preserved beneath the ever-deepening layers.

First, scientists remove a small stratigraphic (layered) core from the deepest portion of a wetland basin with a special instrument. The core may range in length from one foot to 30. On the bottom are the oldest pollen microfossils, on the top the youngest. Depending upon its length and the rapidity with which its layers have accumulated, the core may record vegetational changes as far back as 15,000 years.

The next step is to segregate the pollen grains in an uncontaminated condition for detailed laboratory work. By examining the content of the successive layers under a microscope, palynologists can identify the plant family, the genus, and occasionally even the species from which a pollen grain issued. The results of such research make possible a wide range of studies—from reconstructing the forest environments of early *Homo sapiens* to charting postglacial plant migrations.

Palynological investigation provides a historical perspective on vegetational change and the stability of plant communities through time. Though we tend to regard natural areas—like those protected by The Nature Conservancy—as unchanging, the pollen grains tell a different story. During the last 15,000 years, for example, the species composition of forest communities in New England seldom stayed the same for more than three thousand years at a time.

According to pollen evidence from eastern seaboard lakes, summarized by M. B. Davis in 1976, "waves" of migrant plant species moved slowly northward from refugia in warmer climes of the southeastern United States—following the retreat of continental ice—to regain the ground of their former ranges. The speed of their movements depended on their ability to spread under a warming postglacial climate.

"Though we tend to regard natural areas—like those protected by The Nature Conservancy—as unchanging, the pollen grains tell a different story."

Spruce (*Picea*) grew throughout the Midwest and at low elevations in the East at the height of the last glaciation (about 18,000 years ago) and moved northward as the ice retreated. Jack pine (*Pinus banksiana*), followed by white pine (*P. strobus*), constituted the first wave; both reached the Great Lakes area and New York State about 11,000 years ago. Hemlock (*Tsuga canadensis*) came next, arriving in these areas some 8,000 years ago. A series of hardwoods migrating at different

speeds followed, and the last, the American chestnuts (*Castanea*), arrived in New England about 3,000 years ago. Of course, this "victory" was followed by stunning defeat as the chestnut blight destroyed chestnut trees (over the range of species) between 1904 and 1940. These phenomena and many more are faithfully recorded in the accumulating mud layers of the region's wetlands.

The Nature Conservancy's Cranesville Swamp Preserve (for more on Cranesville, see page 12) is one site where pollen studies have revealed local forest history. Straddling the border between West Virginia's Preston County and Maryland's Garrett County, the swamp runs about two miles long and a quarter to a half a mile wide on the Appalachian Plateau. Its elevation is approximately 2,500 feet. The most ecologically significant aspect of Cranesville is the relict colony of northern plants and animals it supports. Best known of the refugium's features is the southernmost stand of tamarack or larch (*Larix laricina*).

Palynologist Donald Cox described an 11-foot peat core he took in Cranesville Swamp in 1968. The upper third of the sediment consisted of brown wood peat overlying fibrous sedge peat, suggesting periods of flooding and drying. This graded downward into a brown lake mud, indicating open water. At the bottom of his 11-foot core, Cox found a sandy clay over a clay.

The pollen sequence is undated, but by correlation with other lakes of the region—where carbon 14 dates are available—the first vegetation phase (where shrub and herb pollen grains outnumber those of trees) probably represents tundra at the height of the full glacial period, more than 12,500 years ago. According to other work in the region, spruce—the chief tree pollen—grew in the lowlands, while at higher elevations freeze-thaw processes stirred the soil, producing a treeless subarctic landscape.

Following this early phase, tree pollen dominated the assemblage (from about 12,000 to 10,000 years ago) and the mixture of spruce, pine, and fir presumably marks an interval of boreal forest at the site. Ground cover plants included grasses, sedges, birches and related shrubs, willows, members of the sunflower family, and various mosses. Small numbers of scattered hardwoods (oak, maple, elm, and ash) may have been present in protected sites nearby, or their pollen may have blown in from more distant sources. The climate was cold and dry.

The typical early postglacial pine forest zone that usually follows (approximately 10,000 to 8,000 years ago) is missing at Cranesville and also at a site 100 miles distant. The sandy texture of the sediment at the top of the spruce zone suggests that a drop in the water level has obscured the record of that succeeding interval. Regional data indicate that a dry, fire-prone pine forest period occurred during this "missing" zone. The climate was probably warming rapidly.

An important rise in hemlock (some 7,000 years ago) heralded a northern hardwood interval at Cranesville, when the lake stood at high levels. At first hemlock dominated; oak and birch were important, with some beech, walnut, ash, and maple. Understory plants included alder, holly, elderberry and an abundance of ferns and mosses. This forest phase occurred during a cool, moist period.

"By affording us a vision of plant communities long gone, pollen studies have widened the field of environmental inquiry and deepened our scientific understanding."

In the succeeding zone, oak dominated, and chestnut—a new immigrant from the south—became important. The regional forest was enriched with temperate hardwoods (hickory, beech, birch, maple, ash, walnut, black gum, linden). Heaths, holly, alder, and mosses were significant as ground cover plants. The climate was warm, probably warmer than it is now. The lake basin at Cranesville had filled with peaty sediments.

In the final phase of Cranesville Swamp's history, trees grew on the marsh surface and a wood peat was deposited. The dramatic rise in spruce pollen at this time may mark the appearance of red spruce in the swamp during the "little Ice Age" of the last 2,000 years. Though Cox did not report seeing pollen of tamarack, the likelihood is that it was present during this cool period, when northerly plants were extending their ranges southward.

The palynological findings at Cranesville Swamp serve as a register of the eastern seaboard's vegetational history. They show that the associations of plants we see on today's landscape are relatively new, their current configuration having resulted from botanical changes forced by complex climatic shifts over the millenia. By affording us a vision of plant communities long gone, pollen studies have widened the field of environmental inquiry and deepened our scientific understanding.

NEW PROJECTS

CONNECTICUT

Onion Mountain (Town of Canton). On the precipitous slopes of this basaltic ridge, two distinct biological communities prosper in proximity. Thanks to Marvin H. Stocking, who sold his 100-acre property to the Conservancy at six percent of its estimated fair market value, both regimes—the west slope's dry, trap-rock association and the rich wet-soil flora of the east—are safe. Though most east-facing slopes in the state are dry, owing to their aspect, gradient, and soils, this one grows forest ferns, spleenworts, deep-soil hardwoods and softwoods . . . vegetation commonly found in lowlands and on limestone. The mountain preserve, which will be managed by the Connecticut Chapter, also bears a population of a regionally significant plant species, climbing fumitory (*Adlumia fungosa*).

FLORIDA

Apalachicola Bluffs and Ravines Preserve (Liberty County). One of the temperate world's richest paleorefugia (see page 11), this expanse of jungly ravines, longleaf pine sandhills, and sheltered slopes is a botanical treasure-house. The initial purchase of 1,158 acres here on the Florida Panhandle (a 4,100-acre preserve is envisioned) made partial use of the largest individual gift in the Florida Chapter's 20-year history. The ravines alone harbor several plant species found nowhere else in the world: *Torreya taxifolia* (an evergreen that closely resembles southern Appalachian fossils dating back 100 million years), Florida yew, and *Croomia pauciflora*. Field botanists under contract with the Florida Field Office have recently identified in the Apalachicola Bluffs area seven plants previously unknown in the state. Of the 342 species currently included in the Florida Natural Areas Inventory, 23 occur on the property (including a number of northern species at their southern limits), 52 in the vicinity. The new preserve—which ribbons a stretch of the Apalachicola, one of six rivers charted for protection under the Conservancy's Rivers of the Deep South Program—will be managed by the Florida Chapter.

ILLINOIS

Levee Lake (Madison County). By means of a complex property-exchange transaction, the Illinois Chapter has assisted the Illinois Department of Conservation in acquiring a 222-acre stretch of open wetlands and bottomland woods in the southwestern part of the state. Named for a levee on its northwest border, the site is significant for its shrub swamp community of willows and buttonbush. It is charted for dedication as a state nature preserve.

MICHIGAN

Thunder Bay River State Forest (Montmorency County). A gift of Edwin A. Hardy, this heavily forested eight-acre inholding slopes down to the swampy floodplain of Thunder Bay River, a watercourse currently under consideration for state protection as a "natural river." Great blue herons that nest nearby frequent the area's spruce, tamarack, and white pine woods. Upon transfer to the Michigan Department of Natural Resources, the tract will be managed as a special unit of the state forest.

MINNESOTA

MacDougall Homestead — Addition — (Morrison County). With the signing of 17 separate deeds, by the holders of 17 separate undivided interests, the Conservancy took title to this 40-acre tract. The Sarah-Maud W. Sivertsen Trust funded the purchase. Eighteen distinct natural communities persist here on the east bank of the Mississippi River, including tamarack bog, white pine wood, maple-basswood forest, oak savanna, prairie bluff, and floodplain forest. Recognized by the state's natural heritage program as an "element of special concern," the preserve's pine grove serves as a rookery for great blue herons. Plans call for state dedication as a scientific and natural area.

MISSISSIPPI

Shipland Wildlife Management Area (Issaquena County). A 3,642-acre sweep of bottomland hardwoods, sandbars, and Mississippi River islands has been secured for the Mississippi Wildlife Heritage Committee with Conservancy assistance. The delta property's forest (cottonwood, sycamore, hackberry, sweetgum, box elder, honey locust, oak, ash, ironwood, persimmon, elm) hosts numerous songbirds, both residential and migratory, and woodland mammals. Shipland is a project of the Conservancy's Rivers of the Deep South Program.

Susan Bournique

Chapman's Pond

"All nature is your congratulation. . . ." With these words of Henry David Thoreau, the Conservancy's Ken Olson thanked a broad-based, bipartisan alliance for saving Chapman's Pond. Last summer, when the Connecticut site was dedicated as a nature preserve, the large cast of this rescue cheered its finale.

Midway between Boston and New York, only 11 miles up the Connecticut River from Long Island Sound, the 301-acre property is an ecological bonanza, New England backcountry *par excellence*. When it was earmarked for logging and residential development late in '81, the Connecticut Chapter moved quickly to secure an option for its purchase. Seven months and $700,000 later, the most ambitious fundraising campaign in chapter history was successfully completed.

Conservancy scientists identified Chapman's Pond for protection a decade ago. Screened from the main river channel by two small islands, it is the state's only tidally influenced freshwater body—spawning grounds for largemouth bass and northern pike, and habitat for two dozen other fish species. Two plants listed as rare in Connecticut (Torrey's bulrush and water plantain) grow in the floodplain marshland here. And the area's wildlife list, some 250 species long, boasts osprey and bald eagles, coyotes, bobcats, bears.

The protection effort was undertaken by the Conservancy and the East Haddam Land Trust in cooperation with the Connecticut River Gateway Commission, the Middlesex Soil and Water Conservation District, the Eastern Connecticut Resource Conservation and Development Area, and the Soil Conservation Service of the U.S. Department of Agriculture. Endorsed by the State of Connecticut, Department of Environmental Protection, and supported by countless individual citizens—many of whom made gifts towards its preservation—Chapman's Pond is managed by the Connecticut Chapter and the East Haddam Land Trust with technical assistance from the state and the Soil Conservation Service. The preserve is named in honor of spirited conservationist Cynthia B. Carlson, long-time resident of the Connecticut River Valley, where the Conservancy has helped to create 12 other sanctuaries to date.

NEW MEXICO

Owl Canyon (Hidalgo County). Piedmont desert grasslands range undisturbed from narrow woods along this canyon's bottom washes across both side-slopes and up onto the ridgetops: a 1,500-foot ascent. The Southwestern plant community type—increasingly threatened by overgrazing, desertification, subdivision, and destructive recreational use—is a protection priority of the Conservancy's National Critical Areas Conservation Program. The New Mexico Chapter has purchased a 50 percent interest in 1,470 acres here, the remaining interest to be donated by Dr. Elisha Atkins. An adjacent 620-acre parcel will be leased from the Bureau of Land Management. Dr. Robert Scholes, of the Scholes Bio-Research Ranch, will manage the new preserve in conjunction with the New Mexico Chapter.

NEW YORK

Atlantic Double Dunes — Addition — (Suffolk County). Key additions extend protection for one of the nation's two remaining undisturbed "double dune" complexes. The Champion International Corporation of Connecticut has donated a 6.2-acre tract that boasts a cranberry bog, and the South Fork/Shelter Island Chapter has purchased 9.3 acres in concert with the Town of East Hampton—thereby averting subdivision in the heart of the assemblage. This nationally significant spread of beach, freshwater marshland, barrier and secondary (double) dunes on the South Fork of eastern Long Island is a major stop-over point for more than 200 migratory bird species—including the nationally endangered peregrine falcon—and an overwintering site for internationally endangered Ipswich sparrows. America's only marine-edge amphibian, Fowler's toad, thrives here, as do state-endangered plants such as the rose pogonia orchid. The South Fork/Shelter Island Chapter currently manages 118 acres at Atlantic Double Dunes and has targeted another 75 for protection.

NORTH CAROLINA

Pretty Pond (Robeson County). Ranging in size from two acres to more than a thousand, elliptical, pond-like "Carolina bays" (also known as whale wallows, loblollies, and black bottoms owing to the mystery of their origins) once stippled the coastal plain from North Carolina to Georgia. Today they are endangered ecosystems—and, in Conservancy parlance, national critical areas. The purchase of 32 acres in two parcels protects Pretty Pond, a recent prize of the Conservancy's Carolina Bays Project. Populations of state-endangered *Rhus michauxii* (Michaux's false sumac) and state-threatened *Rhexia aristosa* (awned meadowbeauty) flourish in the clay-based soils of the shallow pond—as does *Iva microcephala,* a peripheral herb species. The North Carolina Nature Conservancy will manage the preserve.

OHIO

Arcola Creek (Lake County). It's the mouth of Ohio's most ecologically significant unprotected estuary, a major protection objective of the Ohio Lands Forever Campaign. A conservation easement on 21.5 acres—donated by the Board of Lake County Commissioners—and the purchase of a 16-acre tract nearby safeguard creek waters, marshland, beach, and open water on the south end of Lake Erie. A sandspit in the creek mouth supports beach pea, sea rocket, seaside spurge, purple sandgrass, and other rare plants; the marsh is a breeding area for numerous fish; and the creek itself supports a major smelt run. The Ohio Chapter is working to extend its assemblage—the goal, a preserve some 85 acres in extent.

WISCONSIN

Walter and Rose Zinn Natural Area—Addition—(Washington County). Just 35 miles from downtown Milwaukee, a wilderness lake mirrors its surroundings: tamarack swamp, sedge bog, shrub carr (wetland), and upland hardwood forest. A second generous gift of land from Rose Zinn protects 40 acres on the southern end of Beck Lake—habitat for nesting and migrating waterfowl, including wood ducks, blue-winged teal, and mallards. Among the preserve's rare plant species are slender bog arrow grass, yellow and showy lady's slipper orchids: all of them listed for protection in the state until this year. The Wisconsin Chapter manages the 120-acre preserve.

CORRECTION

In the September/October issue (on page 26), the pine woods treefrog was incorrectly identified by our editors as a federally listed endangered species. We had the Florida population of pine *barrens* treefrogs in mind—but even there, delisting is imminent. Our apologies!

COTTAGES AVAILABLE AT MILE HI

Modern housekeeping cottages overlooking a mountain creek are available for rental year-round at the Conservancy's Mile Hi Preserve. Located 90 miles southeast of Tucson in the Huachuca Mountains, the Mile Hi stretches across the mouth of Ramsey Canyon, one of the most lovely and biologically diverse canyons in southern Arizona. To arrange a visit or obtain a brochure and birdlist, write: The Mile Hi, RR 1, Box 84E, Hereford, Arizona 85615. Phone: (602) 378-2785.

Annual Meeting Held in Washington, D.C.

"The unique challenge that we face is to protect our natural inheritance against the awesome waste that this generation of temporary possessors has proven itself so capable of committing. But thanks to the work and example of The Nature Conservancy, we may yet prove ourselves better custodians than any of us had the right to believe just a few short years ago." With these words, former senator and State Department Counselor James L. Buckley addressed the Conservancy's Annual Awards Banquet, which concluded the Annual Meeting and Conference in Washington, D.C., on October 1 and 2.

The weekend meeting began with an opening reception, a celebration of regional diversity set against a backdrop of foliage at the U. S. Botanic Garden. Saturday morning members sat in on open meetings of the Board of Governors to hear discussions on upcoming land protection projects, the Conservancy's International Program, and the "1988 Plan." Following a luncheon, business of the Conservancy's Annual Meeting session included a slide-illustrated report by President William D. Blair, Jr., and announcement of Board of Governors election results. Saturday afternoon attendees took tours of the National Zoological Park, the National Arboretum, or Dumbarton Oaks.

More than 80 members participated in post-conference tours to Cape May, New Jersey, and the Conservancy's Virginia Coast Reserve. Voyagers to Cape May enjoyed two days of birding and touring on the historic peninsula with a new Conservancy preserve at its tip—a spot where migrating raptors stop to rest before braving the treacherous winds of Delaware Bay. Parramore Island, the largest of the 13 Conservancy-protected Virginia barrier islands off the Delmarva Peninsula, was the destination of the second group, which later enjoyed an "Eastern Shore dinner" at historic Brownsville, headquarters of the Reserve.

Mark your calendars now for the Conservancy's 1983 meeting slated for October 20 through 22 in Tucson, Arizona. A task force of Arizona Chapter volunteers is already planning events for the meeting, including field trips to the Conservancy's Mile Hi Ranch and Patagonia preserves, as well as the Sonora Desert Museum. For information on the Tucson meeting (to be mailed May 1, 1983) please write: Annual Meeting Coordinator, The Nature Conservancy, 1800 N. Kent Street, Arlington, Virginia 22209.

Oak Leaf Awards 1981

Once a year The Nature Conservancy acknowledges the outstanding efforts of its members through the presentation of the Oak Leaf Awards. This award, symbolized by a green and gold lapel pin, is given in recognition of especially dedicated service and support toward achieving the Conservancy's objectives.

A founding trustee of the Eastern Pennsylvania Chapter, **Dorrance R. Belin** has provided outstanding leadership, diplomatic, and legal skills in forming a strong Eastern Pennsylvania Chapter board of trustees and in creating a productive and professional state field office and an increasingly effective state program.

Under **Alexander Calder, Jr.,** as chairman and chief executive officer, the Union Camp Corporation has placed 77,000 acres of ecologically important land under permanent protection through cooperative efforts with The Nature Conservancy. In his personal capacity Mr. Calder has served as an active member of the Conservancy Board of Governors and the Corporate Relations Committee. His example in demonstrating that conservation and corporate best interests can and should coincide, and in advancing a partnership between the Conservancy and the American business community, has been of incalculable public benefit.

Barbara H. Conolly began her association with the Conservancy in 1970. Since then, she has served as one of the Long Island Chapter's most dedicated and effective volunteers. An accomplished ornithologist and botanist, Mrs. Conolly was a member of the chapter's board of trustees from 1972-76. She initiated the Leader's Program in the late 70's, personally training Conservancy members as naturalists to enable them to lead chapter or educational hikes. Mrs. Conolly also volunteers her time to the technical advisory committee of the Long Island Chapter to conduct inventories on potential land acquisitions.

One of the best known conservationists in Connecticut, **Peter B. Cooper** served for four years as highly effective and dedicated chairman of the Connecticut Chapter, which under his leadership undertook and completed the ambitious and highly successful Chapman's Pond project, the largest fund raising campaign in the history of the Connecticut Chapter. As an attorney, Mr. Cooper has donated his time to the Conservancy and he represents the Conservancy on Connecticut Governor William O'Neill's Heritage Task Force.

A past member of the Conservancy's national Board of Governors, in which capacity he served for years as chief steward of the Conservancy's financial resources, **Captain H. P. J. (John) Duberg** has been a dedicated and effective supporter of Conservancy efforts. He played key roles in the creation of the Blowing Rocks Sanctuary in Florida and the nearby Hobe Sound National Wildlife Refuge. Captain Duberg was instrumental in the re-establishment two years ago of the Florida state office and he has been a strong proponent of the Conservancy's Tiger Creek Nature Preserve.

For 20 years **Fred Harden** has generously devoted himself to the development and support of the Conservancy's programs in Florida. One of the original organizers of the Florida Chapter, he has twice served as chairman of the chapter, and is past chairman of the chapter's stewardship committee. His leadership and dedication have been central elements in the growth and the progress of the chapter.

June Janis's political and negotiating skills were the keystone of the effort to save Michigan's Skegemog Lake. Mrs. Janis has been a member of the Michigan Chapter board since its inception and has been successful in bringing over 600 acres under protection as the chairperson and co-founder of the Skegemog Lake Wildlife Area Project Committee.

David L. Kinnamon was chairman of the Wisconsin Chapter's fundraising committee for over five years, and substantially broadened the chapter's support from Wisconsin's foundations and corporate community. In addition Mr. Kinnamon has been a prime mover for numerous critical land acquisition projects, among which are Rush Creek, Chiwaukee Prairie and Baraboo Hills.

A trustee and vice-chairperson of the Ohio Chapter, **Barbara Lipscomb** has headed the highly ambitious Ohio Lands Forever Campaign fund raising drive with enormous energy, persistence, and skill. As chairperson of the drive, Mrs. Lipscomb has been the organizer of the chapter's largest and most successful campaign, safeguarding eleven top priority natural areas in Ohio.

A charter member of the Central New York Chapter's board of trustees—and its chairperson from 1977-81—**Harriet T. Marsi** has long been a leader in Conservancy activities, in New York and beyond. It was through Mrs. Marsi's persistence that the New York Chapter was successful in negotiating a successful critical 100-acre addition to the El Dorado Beach preserve on the eastern shore of Lake Ontario. Mrs. Marsi is currently editor of the chapter's newsletter.

Robert Menke has played a critical role in the outstanding achievement of the Indiana Chapter over the past seven years by serving as a model of personal commitment to the Conservancy and its goals. As vice-chairman of the chapter, Mr. Menke personally solicited most of the business leaders of the state for the Conservancy. He also donated two key tracts to preserve the 100-mile Knobstone Trail and provided vital support to the Indiana Registry Program.

The leadership of **John G. Ordway, Jr.,** was the decisive element in the recent successful effort to protect the important wilderness areas along northern Wisconsin's Brule River. His sponsorship of a study of the possibilities and his gifts to the Conservancy's Wisconsin Chapter of an easement on Cedar Island were catalytic in negotiating a series of conservation easements. In addition, as a trustee of the Goodhill Foundation, Mr. Ordway has helped to realize not only extraordinary individual projects such as the protection of the Niobrara River Valley, but also the establishment of the Conservancy's National Critical Areas Conservation Program, which today is the largest and most important coordinated effort, public or private, to preserve the biological diversity of our country.

Simon Primm III is a long-time trustee and current chairman of the Missouri Chapter. Under his leadership the chapter is undertaking an expanded program; opening a staffed state office to help carry it forward; and building the increased financial and other support which these efforts require. A past member of the Conservancy's Board of Governors, Mr. Primm's influence with the state was invaluable in establishing the Missouri Heritage Program.

As a chapter trustee, regional land steward for north-central Indiana, vice chairman for stewardship, and chairman of the Barker Woods Committee, **Dr. Victor Riemenschneider** has long provided outstanding leadership to the Conservancy program in Indiana. Dr. Riemenschneider brought the Spicer Lake Project to the Conservancy's attention and has been personally responsible for monitoring it and sharing his scientific knowledge to make the project a success.

For seven years **John Sherwood** has led the Conservancy's conservation programs as both a trustee and chairman of the former Northern California Chapter and presently as a board member of the newly combined statewide chapter and as chairman of the board's membership committee. Mr. Sherwood's personal efforts were directly responsible for establishing the Sacramento Oxbow Preserve, for increasing Corporate Associate membership and in a large measure for unifying the California Chapters in a single strong state program capable of carrying through successfully the largest single state effort in our history, the $15 million California Critical Areas Program. He has also played an active part in helping to develop the Conservancy's long-range plan.

Stewardship Awards

It is estimated that more than 5,000 volunteers are engaged in the stewardship of Conservancy preserves. The President's Stewardship Award is presented to at least one committee and one individual who have contributed significantly to the advancement of the art of stewardship on Conservancy preserves.

The Battle Creek Cypress Swamp Advisory Committee has worked very effectively in serving both the interest and needs of the community in developing an outstanding educational program and in serving the needs of The Nature Conservancy to preserve the swamp. Through the years the Committee has worked closely with the Calvert County Commissioners in developing and implementing a master plan for the preserve. The County is very proud of Battle Creek and its preserve committee.

Jack Zaninovich has been one of the Conservancy's most active and helpful volunteers for almost 15 years. Through his efforts the Conservancy has succeeded in protecting remnants of the San Joaquin Valley in California. He has been personally involved in everything from botanical surveys to controlled burns to water management, and has made himself the welcome mentor, friend and helper of all the preserve managers in the valley.

Annual Chapter Awards

The Outstanding Chapter Award is presented each year by the Board of Governors to the chapter with the best overall performance in all areas of Conservancy work. This year the award is presented to the **North Carolina Chapter** for its outstanding achievements during 1981.

The Outstanding Chapter Progress Award is presented to the chapter that made the greatest overall progress in all program areas during the year. This year the award is presented to the **Wisconsin Chapter** for accomplishments of 1981.

ATTENTION!

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NEW CORPORATE ASSOCIATES

A corporation becomes a Corporate Associate of The Nature Conservancy upon contributing between $1,000 and $10,000 annually to the operations of the organization.

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